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TRANSMITTAL FORM (to be used for all correspondence after initial filing)	Application Number	10/536,571
	Filing Date	November 2, 2005
	First Named Inventor	Taro KISHIBE, et al.
	Art Unit	2811
	Examiner Name	To Be Assigned
	Attorney Docket No.	AOY-3992US
Total Number of Pages in This Submission		16

ENCLOSURES (Check all that apply)		
<input type="checkbox"/> Fee Transmittal Form <input type="checkbox"/> Fee Attached	<input type="checkbox"/> Drawing(s)	<input type="checkbox"/> After Allowance Communication to TC
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Firm Name	RatnerPrestia		
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Printed Name	Lawrence E. Ashery		
Date	March 1, 2006	Reg. No.	34,515

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of: Taro KISHIBE, et al.

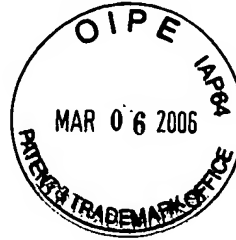
Serial No.: 10/536,571

Group No.: 2811

Filed: November 2, 2005

Examiner: To Be Assigned

For: METHOD AND APPARATUS FOR
ESTIMATING ROTOR POSITION OF
SWITCHED RELUCTANCE MOTOR,
AND METHOD AND APPARATUS FOR
SENSORLESS CONTROL OF
SWITCHED RELUCTANCE MOTOR (AS
AMENDED)



Filing Receipt Corrections
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Error in

1. ☐ Applicant's name
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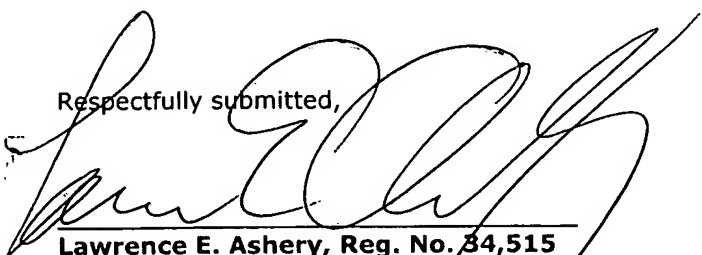
Correct data

- 1.
- 2.
3. **METHOD AND APPARATUS FOR
ESTIMATING ROTOR POSITION OF
SWITCHED RELUCTANCE MOTOR, AND
METHOD AND APPARATUS FOR SENSORLESS
CONTROL OF SWITCHED RELUCTANCE
MOTOR (Preliminary Amendment filed
05/26/05)**
- 4.
- 5.
- 6.
- 7.

3. No fee is due.

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Valley Forge, PA 19482-0980
(610) 407-0700

Respectfully submitted,


Lawrence E. Ashery, Reg. No. 34,515

CERTIFICATE OF MAILING (37 CFR 1.8a)

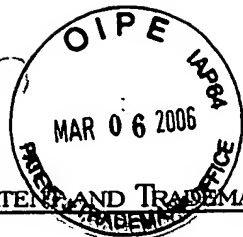
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APPL NO.	FILING OR 371 (c) DATE	ART UNIT	FIL FEE REC'D	ATTY. DOCKET NO	DRAWINGS	TOT CLMS	IND CLMS
10/536,571	11/02/2005	2811	3090	AOY-3992US	21	12	11

52473
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Applicant(s)

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Power of Attorney: The patent practitioners associated with Customer Number 52473.

Domestic Priority data as claimed by applicant

This application is a 371 of PCT/JP02/12412 11/28/2002

Foreign Applications

Projected Publication Date: 05/25/2006

Non-Publication Request: No

Early Publication Request: No

Title

Method and apparatus for estimating rotor position and for sensorless control of a switched reluctance motor

*of switched reluctance motor
and method and apparatus*

COPY



AOY-3992US

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appln. No: To Be Assigned
Applicant: T. Kishibe et al.
Filed: Herewith
Title: METHOD AND APPARATUS FOR ESTIMATING ROTOR POSITION AND FOR
SENSORLESS CONTROL OF A SWITCHED RELUCTANCE MOTOR
TC/A.U.:
Examiner:
Confirmation No.:
Docket No.: AOY-3992US

PRELIMINARY AMENDMENT

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Sir:

Prior to examination, please amend the above-identified application as follows:

- ☒ **Amendments to the Title** begin on page 2 of this paper.
- ☒ **Amendments to the Specification** begin on page 3 of this paper.
- ☒ **Amendments to the Claims** are reflected in the listing of claims which begins on page 4 of this paper.
- ☐ **Amendments to the Drawings** begin on page _____ of this paper and include an attached replacement sheet(s).
- ☐ **Amendments to the Abstract** are on page _____ of this paper. A clean version of the Abstract is on page _____ of this paper.
- ☐ **Remarks/Arguments** begin on page _____ of this paper.
- ☒ **Please enter the enclosed Article 34 Amendment.** ←

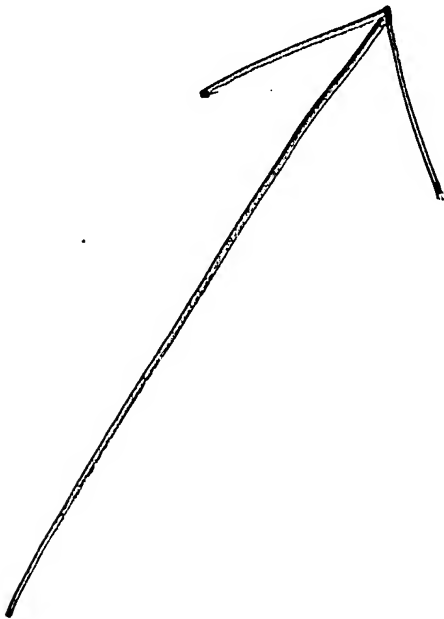
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Amendments to the Title:

Please replace the title with the following:

~~METHOD AND APPARATUS FOR ESTIMATING ROTOR POSITION AND FOR SENSORLESS
CONTROL OF A SWITCHED RELUCTANCE MOTOR~~

METHOD AND APPARATUS FOR ESTIMATING ROTOR POSITION OF SWITCHED RELUCTANCE
MOTOR, AND METHOD AND APPARATUS FOR SENSORLESS CONTROL OF SWITCHED
RELUCTANCE MOTOR



COPY

Amendments to the Specification:

Please add the following new paragraph after the title and before the paragraph starting on page 1, line 6:

THIS APPLICATION IS A U.S. NATIONAL PHASE APPLICATION OF PCT INTERNATIONAL APPLICATION PCT/JP2002/012412.

COPY

Amendments to the Claims: This listing of claims will replace all prior versions, and listings, of claims in the application

Listing of Claims:

1. (Previously Presented) A control method of a switched reluctance motor comprising:
 - (a) sensing a d.c.-link voltage V_{dc} and a phase current I_{ph} ;
 - (b) calculating a flux-linkage λ_{ph} of an active phase from the sensed d.c.-link voltage V_{dc} and the sensed phase current I_{ph} ;
 - (c) comparing the calculated flux-linkage λ_{ph} with a reference flux-linkage λ_r , the reference flux-linkage λ_r related to a reference angle θ_r which lies between angles corresponding to aligned rotor position and non-aligned rotor position in the motor; and
 - (d) controlling a turn-off angle θ_{off} of each active phase and a turn-on angle θ_{on} of the next active phase, based on a timing at which the calculated flux-linkage λ_{ph} becomes greater than the reference flux-linkage λ_r .

2. (Previously Presented) A control method of a switched reluctance motor comprising:
 - (a) calculating an estimated rotor position θ_{est} by adding up an incremental rotor angle $\Delta\theta$ every predetermined control period;
 - (b) sensing a d.c.-link voltage V_{dc} and a phase current I_{ph} ;
 - (c) calculating a flux-linkage λ_{ph} of an active phase from the sensed d.c.-link voltage V_{dc} and the sensed phase current I_{ph} ;
 - (d) comparing the calculated flux-linkage λ_{ph} with a reference flux-linkage λ_r , the reference flux-linkage λ_r related to a reference angle θ_r which lies between angles corresponding to aligned rotor position and non-aligned rotor position in the motor;
 - (e) when the calculated flux-linkage λ_{ph} becomes greater than the reference flux-linkage λ_r during the active conduction of a phase, performing once the following procedures including,
 - (a₁) determining estimated rotor position information θ_{cal} which is set at the reference angle θ_r related to the flux-linkage λ_r , or
 - (a₂) determining estimated rotor position information θ_{cal} from the flux-linkage λ_{ph} by using either one of a predetermined flux-linkage model or inductance model, or

- (a₃) determining estimated rotor position information θ_{cal} by adding a correction angle Φ to the reference angle θ_r related to the flux-linkage λ_r ; and
- (b) calculating an absolute rotor position θ_{abs} by adding the estimated rotor position information θ_{cal} to a stoke angle of the motor, and
- (c) determining and updating the incremental rotor angle $\Delta\theta$ by processing an error between the absolute rotor position θ_{abs} and the estimated rotor position θ_{est} through either one of a proportional-integral control and a proportional control; and

(f) controlling a turn-off angle θ_{off} of each active phase and a turn-on angle θ_{on} of the next active phase based on the estimated rotor position θ_{est} .

3. (Previously Presented) A control method of a switched reluctance motor comprising:

- (a) sensing a d.c.-link voltage V_{dc} and a phase current I_{ph} ;
- (b) calculating a flux-linkage λ_{ph} of an active phase from the sensed d.c.-link voltage V_{dc} and the sensed phase current I_{ph} ;
- (c) comparing the calculated flux-linkage λ_{ph} with a reference flux-linkage λ_r , the reference flux-linkage λ_r related to a reference angle θ_r which lies between angles corresponding to aligned rotor position and non-aligned rotor position in the motor;
- (d) when the calculated flux-linkage λ_{ph} becomes greater than the reference flux-linkage λ_r during the active conduction of a phase, performing once the following procedures including,

- (a) determining estimated rotor position information θ_{cal} which is set at the reference angle θ_r related to the flux-linkage λ_r ;
- (b) calculating and updating an incremental rotor angle $\Delta\theta$ by using an elapsed time from the instant at which the estimated rotor position information θ_{cal} in the previous cycle is determined; and
- (e) controlling a turn-off angle θ_{off} of each active phase and a turn-on angle θ_{on} of the next phase, based on the incremental rotor angle $\Delta\theta$, and the turn-off delay and turn-on delay relating to the reference angle θ_r .

4. (Previously Presented) A control method of a switched reluctance motor comprising:

- (a) sensing a d.c.-link voltage V_{dc} and a phase current I_{ph} ;
- (b) calculating a flux-linkage λ_{ph} of an active phase from the sensed d.c.-link voltage V_{dc} and the sensed phase current I_{ph} ;
- (c) comparing the calculated flux-linkage λ_{ph} with a reference flux-linkage λ_{rr} , the reference flux-linkage λ_r related to a reference angle θ_r which lies between angles corresponding to aligned rotor position and non-aligned rotor position in the motor;
- (d) when the calculated flux-linkage λ_{ph} becomes greater than the reference flux-linkage λ_r during the active conduction of a phase, performing once the following procedures including,
 - (a₁) determining estimated rotor position information θ_{cal} from the flux-linkage λ_{ph} by using either one of a predetermined flux-linkage model and inductance model, or
 - (a₂) determining estimated rotor position information θ_{cal} by adding a correction angle Φ to the reference angle θ_r related to the flux-linkage λ_r ; and
 - (b) calculating and updating an incremental rotor angle $\Delta\theta$ by using an elapsed time from the instant at which the estimated rotor position information θ_{cal} in the previous cycle is determined; and
 - (c) correcting a turn-on delay and a turn-off delay which are related to the reference angle θ_r based on the estimated rotor position information θ_{cal} ; and
- (e) controlling a turn-off angle θ_{off} of each active phase and a turn-on angle θ_{on} of the next phase, based on the incremental rotor angle $\Delta\theta$, and the corrected turn-off and turn-on delays.

5. (Cancelled)

6. (Previously Presented) A control method of a switched reluctance motor comprising:

- (a) calculating an estimated rotor position θ_{est} by adding up an incremental rotor angle $\Delta\theta$ every predetermined control period;
- (b) sensing a d.c.-link voltage V_{dc} and a phase current I_{ph} ;
- (c) calculating a flux-linkage λ_{ph} of an active phase from the sensed d.c.-link voltage V_{dc} and the sensed phase current I_{ph} ;

(d) comparing the calculated flux-linkage λ_{ph} with a plurality of reference flux-linkages λ_m ($n=1,..,k$), each of the reference flux-linkages λ_m ($n=1,..,k$) related to each of reference angles θ_m ($n=1,..,k$) which lie between angles corresponding to aligned rotor position and non-aligned rotor position in the motor;

(e) each time the calculated flux-linkage λ_{ph} becomes greater than each of the reference flux-linkages λ_m during the active conduction of a phase, performing once the following procedures including,

(a₁) determining estimated rotor position information θ_{caln} ($n=1,..,k$) which is set at the reference angle θ_m related to the flux-linkages λ_m , or

(a₂) determining estimated rotor position information θ_{caln} ($n=1,..,k$) from the flux-linkage λ_{ph} by using either one of a predetermined flux-linkage model or inductance model, or

(a₃) determining estimated rotor position information θ_{caln} ($n=1,..,k$) by adding a correction angle Φ to the reference angle θ_m related to the flux-linkages λ_m ; and

(b) calculating an absolute rotor position θ_{abs} by adding the estimated rotor position information θ_{caln} to a stoke angle of the motor, and

(c) determining and updating the incremental rotor angle $\Delta\theta$ by processing an error between the absolute rotor position θ_{abs} and the estimated rotor position θ_{est} through either one of a proportional-integral control and a proportional control; and

(f) controlling a turn-off angle θ_{off} of each active phase and a turn-on angle θ_{on} of the next active phase based on the estimated rotor position θ_{est} .

7. (Previously Presented) A control method of a switched reluctance motor comprising:

(a) sensing a d.c.-link voltage V_{dc} and a phase current I_{ph} ;

(b) calculating a flux-linkage λ_{ph} of an active phase from the sensed d.c.-link voltage V_{dc} and the sensed phase current I_{ph} ;

(c) comparing the calculated flux-linkage λ_{ph} with a plurality of reference flux-linkages λ_r ($n=1,..,k$), each of the reference flux-linkages λ_r ($n=1,..,k$) related to each of reference angles θ_r ($n=1,..,k$) which lie between angles corresponding to aligned rotor position and non-aligned rotor position in the motor;

(d) each time the calculated flux-linkage λ_{ph} becomes greater than each of the reference flux-linkages λ_m during the active conduction of a phase, performing once the following procedures including,

(a) determining estimated rotor position information θ_{caln} ($n=1,\dots,k$) which is set at the reference angle θ_m related to the flux-linkages λ_m ;

(b) calculating and updating an incremental rotor angle $\Delta\theta_n$ ($n=1,\dots,k$) by using an elapsed time from the instant at which the estimated rotor position information θ_{caln} in the previous cycle is determined;

(c) when the calculated flux-linkage λ_{ph} becomes greater than the maximum reference flux-linkage λ_{rk} , averaging the incremental rotor angles $\Delta\theta_n$ ($n=1,\dots,k$) to determine and update an incremental rotor angle $\Delta\theta$; and

(e) controlling a turn-off angle θ_{off} of each active phase and a turn-on angle θ_{on} of the next phase, based on the incremental rotor angle $\Delta\theta$, and turn-off delay and turn-on delay related to the reference angle θ_m ($n=1,\dots,k$).

8. (Previously Presented) A control method of a switched reluctance motor comprising:

(a) sensing a d.c.-link voltage V_{dc} and a phase current I_{ph} ;

(b) calculating a flux-linkage λ_{ph} of an active phase from the sensed d.c.-link voltage V_{dc} and the sensed phase current I_{ph} ;

(c) comparing the calculated flux-linkage λ_{ph} with a plurality of reference flux-linkages λ_m ($n=1,\dots,k$), each of the reference flux-linkages λ_m related to each of reference angles θ_m ($n=1,\dots,k$) which lie between angles corresponding to aligned rotor position and non-aligned rotor position in the motor;

(d) each time the calculated flux-linkage λ_{ph} becomes greater than each of the reference flux-linkages λ_m during the active conduction of a phase, performing once the following procedures including,

(a) determining estimated rotor position information θ_{caln} ($n=1,\dots,k$) from the flux-linkage λ_{ph} by using either one of a predetermined flux-linkage model and inductance model,

(b) calculating and updating an incremental rotor angle $\Delta\theta$ by using an elapsed time from the instant at which the estimated rotor position information θ_{caln} in the previous cycle is determined,

(c) when the calculated flux-linkage λ_{ph} becomes greater than the maximum reference flux-linkage λ_{rk} , averaging the incremental rotor angles $\Delta\theta_n$ ($n=1,\dots,k$) to determine and update an incremental rotor angle $\Delta\theta$, and

(d) correcting a turn-on delay and turn-off delay which are related to the reference flux-linkages λ_{rn} , based on the estimated rotor position information θ_{caln} ; and

(e) controlling a turn-off angle θ_{off} of each active phase and a turn-on angle θ_{on} of the next phase, based on the incremental rotor angle $\Delta\theta$, and the corrected turn-off and turn-on delays.

9. (Previously Presented) A control method of a switched reluctance motor comprising:

(a) sensing a d.c.-link voltage V_{dc} and a phase current I_{ph} ;

(b) calculating a flux-linkage λ_{ph} of an active phase from the sensed d.c.-link voltage V_{dc} and the sensed phase current I_{ph} ;

(c) comparing the calculated flux-linkage λ_{ph} with a plurality of reference flux-linkages λ_{rn} ($n=1,\dots,k$), each of the reference flux-linkage λ_{rn} ($n=1,\dots,k$) related to each of reference angles θ_{rn} ($n=1,\dots,k$) which lie between angles corresponding to aligned rotor position and non-aligned rotor position in the motor;

(d) each time the calculated flux-linkage λ_{ph} becomes greater than each of the reference flux-linkages λ_{rn} during the active conduction of a phase, performing once the following procedures including,

(a) determining estimated rotor position information θ_{caln} ($n=1,\dots,k$) by adding a correction angle Φ to the reference angle θ_{rn} related to the reference flux-linkages λ_{rn} ,

(b) calculating an incremental rotor angle $\Delta\theta_n$ ($n=1,\dots,k$) by using an elapsed time from the instant at which the estimated rotor position information θ_{caln} in the previous cycle is determined, and

(c) when the calculated flux-linkage λ_{ph} becomes greater than the maximum reference flux-linkage λ_{rk} , averaging the incremental rotor angles $\Delta\theta_n$ ($n=1,\dots,k$) to determine and update an incremental rotor angle $\Delta\theta$;

(e) controlling a turn-off angle θ_{off} of each active phase and a turn-on angle θ_{on} of the next phase, based on the incremental rotor angle $\Delta\theta$, and a turn-off delay and a turn-on delay which are determined according to the reference angle θ_{rn} .

10. (Cancelled)

11. (Cancelled)

12. (Previously Presented) A control method of a switched reluctance motor comprising:

- (a) calculating an estimated rotor position θ_{est} by adding up an incremental rotor angle $\Delta\theta$ every predetermined control period;
- (b) sensing a d.c.-link voltage V_{dc} and a phase current I_{ph} ;
- (c) calculating an estimated current I_s from the sensed d.c.-link voltage V_{dc} , the sensed phase current I_{ph} , and a value completely or approximately equal to the minimum value of a motor inductance;
- (d) comparing the sensed phase current I_{ph} with the estimated current I_s ; and
- (e) controlling a turn-off angle θ_{off} of each active phase and a turn-on angle θ_{on} of the next active phase, based on a timing when an error between the sensed phase current I_{ph} and the estimated current I_s becomes equal to or less than a predetermined value.

13. (Previously Presented) A control method of a switched reluctance motor comprising:

- (a) calculating an estimated rotor position θ_{est} by adding up an incremental rotor angle $\Delta\theta$ every predetermined control period;
- (b) sensing a d.c.-link voltage V_{dc} and a phase current I_{ph} ;
- (c) calculating an estimated current I_s from the sensed d.c.-link voltage V_{dc} , the sensed phase current I_{ph} , and a value completely or approximately equal to the minimum value of a motor inductance;
- (d) comparing the sensed phase current I_{ph} with the estimated current I_s ;
- (e) when an error between the sensed phase current I_{ph} and the estimated current I_s becomes equal to or less than a predetermined value, performing once the following procedures including,
 - (a) determining a rotor position θ_{app} which is related to the estimated current I_s in advance,
 - (b) calculating an absolute rotor position θ_{abs} by adding the rotor position θ_{app} to a stoke angle of the motor, and

(c) determining and updating the incremental rotor angle $\Delta\theta$ by processing an error between the absolute rotor position θ_{abs} and the estimated rotor position θ_{est} through either one of a proportional-integral control and a proportional control; and

(f) controlling a turn-off angle θ_{off} of each active phase and a turn-on angle θ_{on} of the next active phase, based on the estimated rotor position θ_{est} .

14. (Previously Presented) A control method of a switched reluctance motor comprising:

(a) sensing a d.c.-link voltage V_{dc} and a phase current I_{ph} ;

(b) calculating an estimated current I_s from the sensed d.c.-link voltage V_{dc} , the sensed phase current I_{ph} , and a value completely or approximately equal to the minimum value of the motor inductance;

(c) comparing the sensed phase current I_{ph} with the estimated current I_s ;

(d) when an error between the sensed phase current I_{ph} and the estimated current I_s becomes equal to or less than a predetermined value, performing once the following procedures including,

(a) determining a rotor position θ_{app} which is related to the estimated current I_s in advance;

(b) calculating and updating an incremental rotor angle $\Delta\theta$ by using an elapsed time from the instant at which the rotor position θ_{app} in the previous cycle is determined; and

(e) controlling a turn-off angle θ_{off} of each active phase and a turn-on angle θ_{on} of the next active phase, based on the incremental rotor angle $\Delta\theta$, and a turn-off delay and a turn-on delay which are related to the rotor position θ_{app} .

15. (Cancelled)

16. (Cancelled)

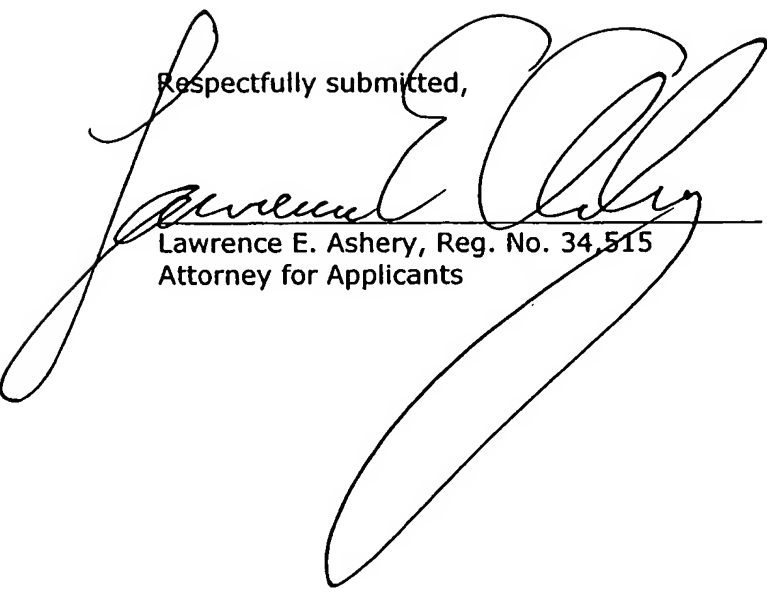
17. (Cancelled)

18. (Previously Presented) An apparatus which is controlled in the method according to any one of claims 1 to 4, 6 to 9, 12 to 14.

19. (Cancelled)

20. (Cancelled)

Respectfully submitted,


Lawrence E. Ashery, Reg. No. 34,515
Attorney for Applicants

LEA/dlm

Dated: May 26, 2005

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